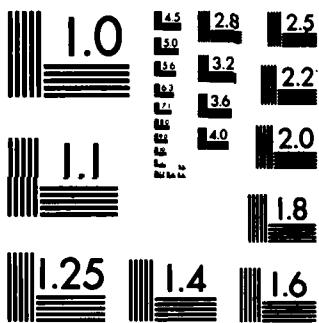


AD-A145 828 NON-LINEAR SYSTEMS IN INFINITE DIMENSIONAL STATE SPACES 1/1
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Interim Technical Progress Report
for period ending 15 June 1984

14

Marshall Slemrod

Department of Mathematical Sciences
Rensselaer Polytechnic Institute

Non-linear systems in infinite dimensional state spaces

AFOSR-81-0172

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Program Summary: M. Slemrod

The program has been divided into two research areas:

- (1) non-linear distributed parameter control systems and
- (2) non-linear continuum dynamics with an emphasis on phase transitions.

(1) Non-linear distributed parameter control systems.

In this research I have formulated a theory of feedback stabilization of a one dimensional string using non-local "pseudo-punctual" magnetic controls (with J. McLaughlin (RPI)). The method of analysis used was non-linear functional analysis, abstract dynamical systems, coupled with continuum mechanics/applied mathematical modeling.

For future work I foresee more research in the area of punctual control of oscillatory systems. McLaughlin and I plan to extend our approach from a string model to a beam equation where we expect to find different phenomena occurring.

(2) Non-linear continuum dynamics

In this research I have centered my focus on materials exhibiting first order phase transitions e.g., van der Waals fluid. Specifically I have attempted to understand the one dimensional dynamics of such materials through such problems as solution of the Riemann initial value problem, chaotic motion of the van der Waals fluid under periodic thermal excitation (with J. Marsden (Berkeley)), applicability of the Lax-Friedrichs finite difference scheme for non-monotone equations of state, implementation of the scheme on a test problem (with J. Flaherty (RPI)), equilibrium configurations of a van der Waals fluid in a finite container (with J. Carr (Heriot-Watt) and M. Gurtin Carnegie-Mellon), modulation of oscillatory waves in the van der Waals fluid (with R. Caflisch (Courant Institute)). The main tools of the research have been dynamical systems theory, real analysis, a high speed digital computer, and the non-linear WKB (two-timing) method.

I believe the work has provided a unified theory of dynamic phase transitions and their numerical computation. As a short term goal I plan to improve the numerical methods and expand them from their current isothermal state. As a longer term goal I would like to test my theory by comparing numerical experiments with laboratory experiments such as those of D. Grady (Sandia) on solids and P. Thompson (RPI) on liquids.

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Publications 1983-1984: M. Slemrod

"One dimensional structured phase transitions under prescribed loads," with J. Carr, M. E. Gurtin, to appear J. Elasticity.

"Controllability for a class of nondiagonal hyperbolic distributed bilinear systems," to appear J. Applied Mathematics and Optimization.

"Periodic thermal perturbations in a van der Waals fluid yield chaos : a Mel'nikov approach," invited paper, Proc. 22nd IEEE Conference on Decision and Control, 1983.

"Distributed Bilinear Control Systems," invited paper, Proc. 22nd IEEE Conference on Decision and Control, 1983.

"Continuum Dynamics of Phase Transitions," Proc. Mathematics Research Center, University of Wisconsin, conference on "Material Instabilities and Phase Transformations," October 1983, Ed. M. Gurtin, Academic Press (1984).

"Lax-Fredrichs and the viscosity-capillarity criteria," to appear Proc. University of West Virginia Conference in Physical Applied Mathematics, July 1983, Eds. J. Lightbourne, S. Rankin, and Marcel-Dekker (1984).

"Numerical Integration of a Riemann Problem for a van der Waals Fluid" (with J. Flaherty) to appear Res. Mechanics.

"Structured Phase Transformations on a Finite Interval" (with J. Carr and M. E. Gurtin), to appear Archive for Rational Mechanics and Analysis.

"Feedback stabilization via dynamic fixed gain controls" (with J. R. McLaughlin), to appear Proc. 23 IEEE Conference on Decision and Control, 1984.

"Scanning control of a vibrating string" (with J. R. McLaughlin), submitted to Applied Mathematics and Optimization.

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SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS									
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.									
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE											
4. PERFORMING ORGANIZATION REPORT NUMBER(S)		5. MONITORING ORGANIZATION REPORT NUMBER(S) AFOSR-TR-84-0818									
6a. NAME OF PERFORMING ORGANIZATION Rensselaer Polytechnic Institute	6b. OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION Air Force Office of Scientific Research									
6c. ADDRESS (City, State and ZIP Code) Department of Mathematical Sciences Troy NY 12181		7b. ADDRESS (City, State and ZIP Code) Directorate of Mathematical & Information Sciences, Bolling AFB DC 20332									
8a. NAME OF FUNDING/SPONSORING ORGANIZATION AFOSR	8b. OFFICE SYMBOL (If applicable) NM	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER AFOSR-81-0172									
8c. ADDRESS (City, State and ZIP Code) Bolling AFB DC 20332		10. SOURCE OF FUNDING NOS. <table border="1"> <tr> <th>PROGRAM ELEMENT NO.</th> <th>PROJECT NO.</th> <th>TASK NO.</th> <th>WORK UNIT NO.</th> </tr> <tr> <td>61102F</td> <td>2304</td> <td>A1</td> <td></td> </tr> </table>		PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.	61102F	2304	A1	
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11. TITLE (Include Security Classification) NON-LINEAR SYSTEMS IN INFINITE DIMENSIONAL STATE SPACES											

Marshall Slemrod

13a. TYPE OF REPORT Interim	13b. TIME COVERED FROM 15/6/83 TO 14/6/84	14. DATE OF REPORT (Yr., Mo., Day) AUG 84	15. PAGE COUNT 3
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16. SUPPLEMENTARY NOTATION

17. COSATI CODES	18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB. GR.

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

The research in this effort has been directed into two main research areas --- nonlinear distributed parameter control systems, and nonlinear continuum dynamics with an emphasis on phase transitions. In the first year, the investigator has formulated a theory of feedback stabilization of a one dimensional string using non-local "pseudo-punctual" magnetic controls. In the second area, work has centered on materials exhibiting first order phase transitions. This should provide a unified theory of dynamic phase transitions and their numerical computation. Ten papers were prepared for presentation or publication during this period.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS <input type="checkbox"/>	21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL CPT John P. Thomas, Jr.	22b. TELEPHONE NUMBER (Include Area Code) (202) 767-5026	22c. OFFICE SYMBOL NM

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